Adamussium colbecki: a carbonate biomass powerhouse in Antarctica

Abstract # 1693

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Abstract

The Antarctic scallop, *Adamussium colbecki* is one of the most common epibenthic marine organisms of Antarctica. While wet weight biomass is known for *A. colbecki,* their carbonate biomass is not well understood. Given concerns about global warming and ocean acidification, it is important to know the carbonate biomass of these scallops. Additionally, the shells of *A. colbecki* harbor calcareous epibionts, and little is known about their carbonate contribution to the benthos.

Results from ignition loss methods indicate that *A. colbecki* valves contain little organic carbon (mean, 0.03 g C_{org}) and are essentially pure carbonate. Thus, cleaned, dried valves can be used for carbonate biomass estimates.

Valve carbonate biomass (sites pooled) appears to increase with depth, but does not vary significantly with depth (mean $CaCO_3$/valve: 6m, 2.30g; 15m, 2.991g; 24m: 2.732g; regression analysis). The mean shell carbonate biomass per valve varied among sites. Using 7.41 g/m^2 per valve, 85 scallops/m^2 would be equivalent to 1275 g $CaCO_3$/m^2!

Epibiont carbonate (e.g., bryozoans, foraminifera; sites pooled) appears to increase with depth (mean $CaCO_3$/valve: 6m: 0.02g; 15m: 0.056g; 24m: 0.22g). These estimates varied by site: Ice Cliff had high shell and epibiont carbonate biomass whereas sites with putative seasonal meltwater flow had the lowest encrusting carbonate biomass. Given its abundance and broad distribution, *A. colbecki* and its shell cohorts may be unrivaled carbonate powerhouses in these undersaturated polar waters.

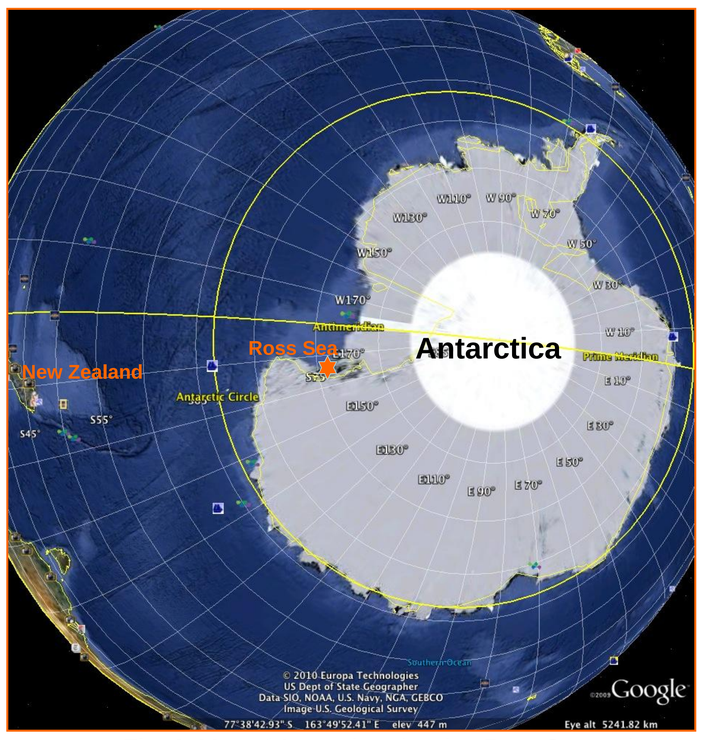
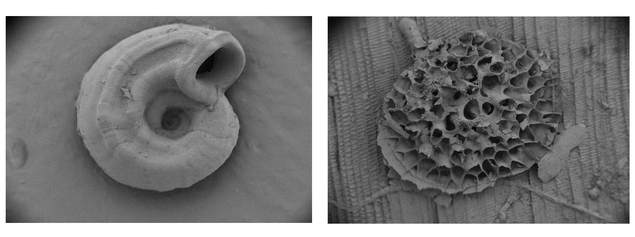


Fig. 1. Map of Antarctica showing Ross Sea region, star marks McMurdo Sound; right map, close up of Ross Sea region showing McMurdo Sound: Study areas are Explorers Cove (orange star) and Ferrar/Double Curtain Glacier (red star) within the New Harbor region (maps from Google Earth 5.0).

Fig 2. *Adamussium* density in shallow water can be 85/m^2 (left; S. Alexander photo); Shells of *Adamussium* are habitat islands for encrusting organisms, such as sponges, and provide food for sea stars and brittle stars (right; S. Harper photo).

Introduction

The Antarctic scallop, *Adamussium colbecki* is one of the most common epibenthic marine organisms of Antarctica (Nicol, 1966; Berkman et al., 2004). It has a broad bathymetric range and a relative abundance reported to be a mean of 78 to 85 individuals/m^2 in shallow water (Stockton, 1984; Guidetti et al., 2006). It is considered an important ecosystem engineer, facilitating nutrient fluxes between the plankton and the benthos (Chiantore et al., 1998). Size frequency distributions are skewed toward larger individuals, suggesting low recruitment in all habitats studied (Guidetti et al, 2006). Growth rate is highly variable among individuals and sites: younger individuals grow faster (10mmyr-1) than older individuals (0.8 mmyr-1; Guidetti et al., 2006); overall, they are a slow-growing long-lived species (Stockton, 1984). *Adamussium* are encrusted with a wide diversity of organisms, including protists (foraminifera), sponges, hydroids, spirorbid & sabellid polychaetes, and bryozoans. Three major groups of encrusters (foraminifera, bryozoans, and spirorbid polychaetes) produce calcareous hardparts (i.e.,tests, shells; Alexander and DeLaca, 1987; Cerrano et al., 2006). However, little is known about the amount of carbonate *Adamussium* and its shell-inhabiting encrusting bionts are producing. Knowing this information would be important for understanding their contribution to the carbonate cycle and for providing the "baseline" benthic data prior to predicted acidification events.

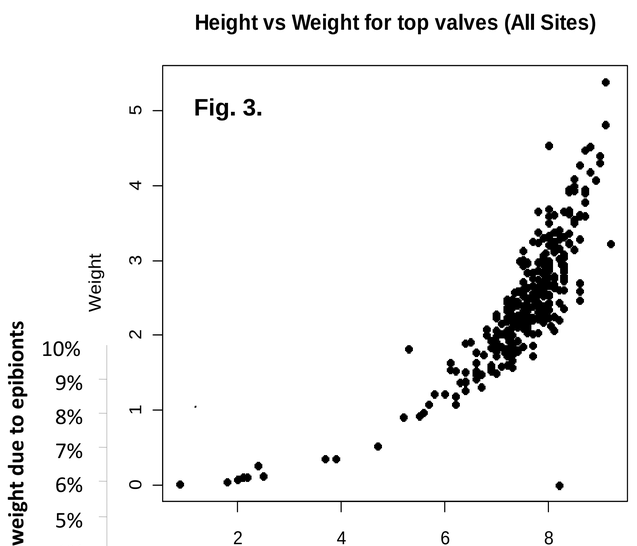


Encrusting spirorbid (left); licheniporid bryozoan (right), SEM images

Methods

Research sites were located within the western part of McMurdo Sound (Ross Sea region; Fig. 1) and included sites from New Harbor region: Explorers Cove (Ice Cliff site) and Ferrar Fjord (Ferrar & Double Curtain Glacier sites). Ice Cliff has coarse-to-fine sediment with limited cobbles (Fig. 2); Ferrar/Double Curtain Glacier sites had a mix of cobbles, boulders and coarse-to-fine sand (S. Bowser & S. Harper, pers. com., 2010).

To determine the carbonate biomass potential of *A. colbecki* and their associated epibionts, top (left) valves were examined from these sites. First, dried shells were weighed for a baseline weight with encrusting bionts. Second, encrusting bionts were removed and weighed; the clean shell was weighed again (dry). To determine the average amount of organic carbon standard ignition loss methods in a muffle furnace were used by powdering 8 cleaned and dried top valves, yielding a mean of 0.03g/Corg (stdev =0.002). Because the shells are essentially pure carbonate (calcite/aragonite mix), the dried valves can be used as the carbonate biomass proxy for *A. colbecki*. Calcareous epibionts were not combusted because of their small size: they were dried at 70^{o}C for 2 hours, cooled in a dessicator bell jar and weighed on a precision balance to get their mass. Epibionts were examined using reflected light or scan electron microscopes.



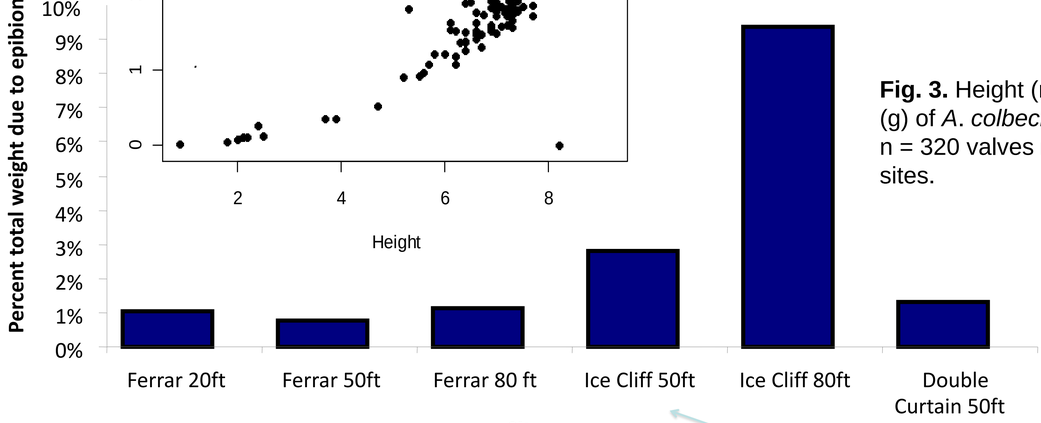


Fig. 3. Height (mm) vs. weight (g) of *A. colbecki* top valves, n = 320 valves representing all sites.

Fig. 4. Percent total weight from epibionts that encrust *Adamussum* shells per site.

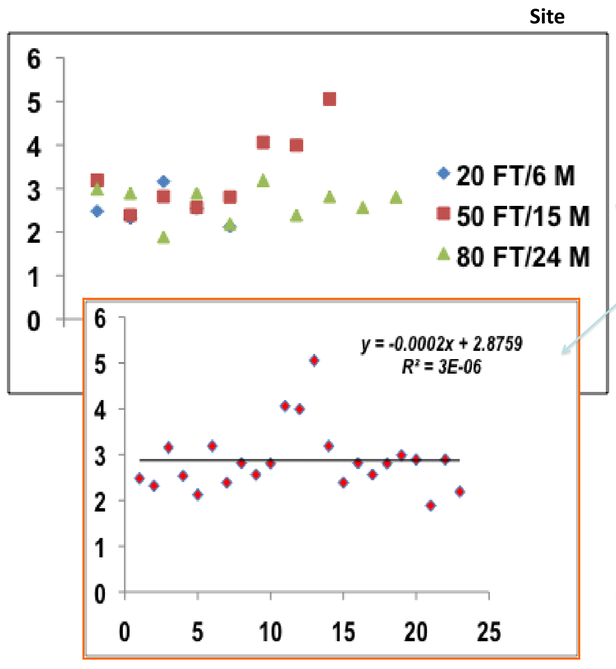


Fig. 5. X/Y scatter plots of carbonate biomass (y-axis: grams of carbonate) per individual valves (x-axis) from Ice Cliff & Ferrar Sites. Regression indicates that carbonate biomass does not differ with depth (6-24m; randomized sample, n = 25 valves).

Table 1. Mean abundance of calcareous encrusting bionts on *Adamussium* shells between Explorers Cove (Ice Cliff) & Ferrar Glacier site.

Site & Depth	Foraminifera	Bryozoan Colonies	Spirorbids
Ice Cliff 15 m	336	2	6
Ice Cliff 24 m	217	5	7
Ferrar 6 m	36	1	1
Ferrar 15 m	19	2	1
Ferrar 24 m	87	7	2

Results & Discussion

An x/y scatter plot of height vs. weight of encrusted left valves of *A. colbecki* shows an exponential increase in weight with larger-sized valves (Fig.3). This excess weight is from epibionts. The percent of weight attributable to epibionts is more pronounced at the Explorers Cove site, especially at the deepest depth (80 ft/24m), whereas Ferrar & Double Curtain sites had less calcareous biont cover (Fig. 4). The major calcareous encrusters are foraminifera, bryozoa and spirorbids (Table 1). Explorers Cove site had more of these calcareous encrusters than the Glacier sites. The foraminiferan, *Cibicides refulgens* was the most common carbonate encruster for every site analyzed (Table 1). These variations in relative abundance and biomass may, in part, be related to differences in seasonal meltwater flow and sediment variations among the sites.

Carbonate biomass produced by *A. colbecki* appears not to increase with depth (all sites pooled; Fig. 5). However, the mean shell carbonate biomass per valve varied among sites, from 4.77 g/m^2 at 15m Ice Berg site to 7.41 g/m^2 at 24m Ice Cliff site in Explorers Cove. Using the high end of 7.41 g/m^2 per valve, 85 scallops/m^2 would be equivalent to 1275g $CaCo_3$/m^2. Using the low average carbonate biomass number (4.77 g/m^2) equates to 810g $CaCO_3$/m^2.

Epibiont carbonate (e.g., bryozoans, foraminifera; sites pooled) appears to increase with depth (mean $CaCO_3$/valve: 6m: 0.02g; 15m: 0.056g; 24m: 0.22g). These estimates varied by site: Ice Cliff had high shell and epibiont carbonate biomass whereas sites with putative seasonal meltwater flow had the lowest encrusting carbonate biomass. Given its abundance and broad distribution, *A. colbecki* and its shell cohorts may be unrivaled carbonate powerhouses in these undersaturated polar waters.

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